AP42 Section: 12.15

Reference: 1

Title: Lead.

Woodbury, WD

Annual Report 1990, Bureau of Mines, US Dept of the Interior

April 1992

LEAD

By William D. Woodbury → (202) 501-9444

Cadmium L&E, section 7
Reference 2

Mercury L&E, section 7
Reference #16

U.S.
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Director

April 1992

NOTE OF EXPLANATION

Due to unusual production delays this year, the Bureau is releasing this report in manuscript form.

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Tables

For comments or further information,
please contact
The Branch of Metals
The Division of Mineral Commodities
U.S. Bureau of Mines
810 Seventh St., NW, MS 5208
Washington, DC 20241-0002
Telephone (202) 501-9444
Fax: (202) 501-9961

LEAD

By William D. Woodbury

Mr. Woodbury, a physical scientist with the U.S. Bureau of Mines, Branch of Metals, had 25 years of mining and civil works geotechnical experience upon becoming the Bureau's lead specialist in 1982. Domestic survey data were prepared by Eraina Dixon and Lisa Conley, mineral data assistants; and international data were prepared by Audrey A. Wilkes, international data coordinator.

Lead is a soft, heavy metal, the most corrosion resistant of the common metals, and one of the oldest metals used by man. Among the nonferrous metals, in terms of tonnage, demand for lead is surpassed only by aluminum, copper, and zinc. In some applications, lead can be toxic, however; its pervasive use in the water distribution system of ancient Rome is theorized by some historians to have contributed to that city's downfall through disorientation from poisoning. However, bridge abutment pads and structural dowelling still standing from that era attribute to its benefits; buildings built in Europe more than four centuries ago still stand under their original lead roofs. For this application lead is still widely used in England on modern structures. Today's worldwide major use of lead is in storage batteries that are used for a multiplicity of functions, including on-line voltage regulation against power surges (for computers), power grid load-leveling, and traditional transportation and communication uses. Other major uses are in soundproofing and radiation shielding, which includes transportation and storage of radioactive materials.

In the first quarter of 1990, reflecting the demand growth that started in the second quarter of 1987, the world cash price for lead on the London Metal Exchange (LME) briefly achieved, in mid-March, a price of 59.8 cents per pound, the same as the alltime record monthly price established in October 1979. Some domestic quotations in mid-March of 65 cents per pound delivered were only 2 cents below the December 1979 price, the highest ever recorded for the United States. However, owing primarily to record battery inventories at yearend 1989, which were not worked down by the end of 1990, demand and prices did not hold up as most of the world appeared headed into a recessionary period. Nevertheless, the year on average was quite profitable for the lead industry as the LME cash price achieved the highest annual level since 1980, and the third highest ever, in spite of increasing metal stocks.

World refined lead output, in spite of record-high U.S. secondary production, was about the same as that of 1989. World demand declined by almost 3%, mostly in the fourth quarter, after 7 years of spectacular growth, but was still the second highest ever. The world secondary sector, responding to environmental challenges, produced at a record level of 46% of world demand, but mine production leveled off and metal stocks rose for the first time since 1987. However, U.S. mine production increased by 15% primarily because the huge new Red Dog Mine in Alaska neared planned capacity output, and the United States was a significant net exporter of lead concentrates for the second consecutive year and for only the second year ever.

Insert table 1 here.

DOMESTIC DATA COVERAGE

Domestic data for lead are developed by the U.S. Bureau of Mines from five voluntary surveys. Typical of these are the combined secondary producer and consumer surveys, both monthly and annual. Of the 230 consuming companies to which a survey request was sent, 201 responded, representing 96% of the total U.S. lead consumption shown in tables 1, 10, 11, 12, and 13. Of the 49 companies producing secondary lead, exclusive of copper base, to which a survey request was sent, 42 responded, representing 93% of the total refinery production of secondary lead, not including that from copper base scrap, shown in tables 1, 7, 8, and 9. Production and consumption for the nonrespondents were estimated using prior-year levels adjusted for general industry trends.

ANNUAL REVIEW

Legislation and Government Programs

There were two significant Federal administrative actions affecting the U.S. lead industry in 1990 by the Environmental Protection Agency (EPA). In midyear, EPA's "third-third" rule became effective for landfilled process wastes under the Resource Conservation Recovery Act (RCRA), as amended. This rule requires pretreatment for most secondary smelter slags, an item of significant cost to smelters. However, the smelters won a 2-year temporary reprieve to a less strict interim standard on appeal. In October, EPA proposed the "final" lead in drinking water standard, in which an "action level" of 10 parts per billion triggers various corrosion control options. The application of this rule could eventually translate into an 80% further reduction of lead in process effluents and discharges at considerable expense to lead producers and some consumers, especially battery plants. After 2 years of intense study, EPA also completed a comprehensive, multimedia (air-land-water) pollution prevention strategy that encompasses both the "old" lead problems in cities and perceived "new" lead problems. This strategy will result in the imposition of significantly stricter multimedia regulations on producers and consumers over the next several years. Immediate consequences of the regulations, to be felt in 1991, will be strict enforcement of existing laws and regulations. In State actions, mandatory lead-acid battery recycling laws became effective in 13 States during 1990, and, in 7 others, laws were passed to become effective on January 1, 1991. These were in addition to nine other States whose recycling laws became effective in 1989, and one in 1988.

Issues

Domestically, the year 1990 was one of furious legislative activity relative to lead as several bills were introduced into both houses of the Congress to deal with various aspects of lead pollution and epidemiology. The primary concern addressed was urban soil and household dust contamination from old, flaking lead-base paint and solid residues from leaded gasoline exhaust emissions. Also addressed were mandatory Federal lead acid-battery recycling and/or minimum required content of secondary lead in batteries, and source reduction by severely reducing lead content of solders and eliminating lead from all food packaging and containers. In addition, taxation of primary lead

and economic incentives for secondary production to reduce environmental "loading" and comprehensive documentation of existing uses, with mandatory new product approvals, was being considered. Extensive yearlong hearings were held at committee and subcommittee levels, but no floor votes were taken, and various amended and combined versions of all proposals were expected to be reintroduced in 1991.

With the exception of the "old lead problem" (primary concern addressed above), the issue of concern emerging publicly for the first time on a grand scale was that with no proven effective "environmental sink" for heavy metals, they simply move from media to media (air-land-water). In doing so it is postulated that they continuously expose the populace more often and in ever-increasing dosages as "virgin" (i.e., newly mined heavy metals) are added to the cycle. However, this hypothesis is dependent on the assumption that dissipative end uses grow proportionately with the overall population and demand, and/or that exposures to both dissipative and nondissipative uses cannot be technologically reduced.

This is a rebuttable presumption illustrated simplistically by the continuously evolving U.S. lead supply-demand pattern itself. From the peak demand year of 1977 (table 2), primary demand has dropped by 370,000 tons mostly because the major dissipative use of lead in gasoline additives has decreased by 200,000 tons, replaced in the market by highly recyclable electrical and transportation uses, which have increased by 200,000 tons. This is reflected in the old scrap production levels for 1990 versus 1977, an increase of 240,000 tons. There has also been a 100,000-ton drop in overall demand, 90% of which was in the chemicals and other miscellaneous use categories, much of which was dissipative. Net imports from worldwide, generally less environmentally regulated sources than our domestic facilities have declined by about 200,000 tons from the primary supply side. Projections for the future (see Outlook section) indicate that this overall decreasing exposure and "loading" trend will continue in the domestic supply-demand pattern. With the establishment of the lead-acid battery as a "fungible," marketable commodity due to a generally more environmentally conscious populace (30 States had mandatory battery recycling laws at yearend) and continuing advances in recycling technology, this scenario will improve even more during the rest of the century, continuing to reduce exposure and the attendant epidemiological effects. Technologic advances in lead-acid batteries, resulting in even longer life, will also continue to contribute to limiting use of lead and exposure thereto.

Insert table 2 here.

Production

Primary.--The increase in domestic mine production of lead in 1990 was attributed primarily to the coming on-stream in February of Cominco Alaska Inc.'s huge Red Dog open pit zinc-lead-silver mine in the Kotzebue region. However, small increases were also realized at virtually all producing zinc-silver and/or zinc-gold mines in Colorado, Idaho, and Montana where lead is a coproduct and/or byproduct. A slight increase in lead output was also

recorded in Missouri, which represented 78% of domestic production (table 3); Alaska and the other three aforementioned States accounted for 18% of the total. Of those mines listed in table 5, the top 15 produced more than 99% of the total or all but 3,800 tons. In terms of corporate ownership, three companies, Doe Run, Asarco Incorporated, and Cominco, accounted for 90% of the total. On the basis of lead in concentrates, the industry performed at only 62% of capacity (table 17), the same as in 1989, because of decreasing primary demand, both domestic (table 2) and worldwide (table 16).

During 1990 in southeastern Missouri, the Doe Run Co. of St. Louis, MO, the Nation's largest integrated lead producer, operated three mine and mill divisions, Buick, Fletcher, and Viburnum, consisting of six mines and four mills, which had an aggregate daily capacity of 26,300 tons of ore according to parent company Fluor Corp.'s annual SEC Form 10-K. In May 1990, Fluor Corp. purchased Homestake Lead Co. of Missouri's 42.5% interest in Doe Run for $125 million in cash and are now sole owners. On a fiscal year basis ending October 31, 1990, Doe Run mined and milled 4.78 million tons of ore grading 5.36% lead compared with 4.35 million tons grading 5.58% in 1989, an increase in contained lead of just less than 6%. This resulted in metal production at Doe Run's integrated smelter-refinery in Herculaneum, MO, of about 231,000 tons of refined lead for the calendar year 1990 compared with about 224,000 tons of refined lead for 1989, an increase of 3%. In addition, Doe Run produced and sold 45,000 tons of copper concentrate and 44,000 tons of zinc concentrate in its fiscal year 1990 from its mines. As of October 31, 1990, these mines had proven ore reserves of approximately 76.8 million tons with an average grade of approximately 4.84% lead, according to Fluor's SEC Form 10-K. Approximately 65% of Doe Run's ore is on properties under Federal mineral leases for terms of 10 to 20 years, renewable for 10 years, for which the company pays the Bureau of Land Management a royalty of 5% of the gross value of concentrates produced.

Asarco operated two mine and mill complexes in southern Missouri, which together produced 82,500 tons of lead in concentrates, the same as in 1989, according to the company's first quarter 1991 special report of "Statistical Data for Securities Analysts." This represented about 72% of the refined lead production from Asarco's integrated smelter-refinery at Glover, MO, in 1990 compared with 75% in 1989. That plant produced 112,000 tons of refined lead in 1990 and 108,000 tons in 1989, according to the report. Asarco purchased Cominco American Inc.'s 50% share of the Magmont Mine production in Iron County, MO, to supplement Glover's feed. Asarco's refinery at Omaha, NE, which receives the lead bullion output of the East Helena, MT, custom smelter, produced 61,000 tons of refined lead in 1990 compared with 65,000 tons in 1989. Asarco also received a 50% share and 37.5% share, respectively, of the production from the Leadville and Galena mines shown on table 5. Asarco's total lead metal production in 1990 was 45% from its own mines, 48% custom, and 7% toll, but at yearend it was estimated that the company had an approximately 85% captive domestic capability if its own mine production were fully optimized.

The Magmont Mine at Bixby, MO, a 50-50 joint venture of Cominco American Inc., the operator, and Dresser Industries Inc., continued to be the Nation's third largest producer, in spite of being only about 3 years from exhaustion.

Surface drilling during the year revealed two minor extensions of the ore body, which partially replaced the ore extracted. Ore recovery from the major 1986 groundfall area was completed in 1990, with recovery and pillar extraction exceeding that from other areas of the mine. According to parent company Cominco Ltd.'s (Canada) annual stockholders report, Magmont milled 984,000 tons of ore grading 7.1% compared with 962,000 tons grading 6.8% in 1989. This yielded 87,000 tons of concentrate grading 78.0% lead compared with 81,000 tons at 77.9% concentration in 1989. The mine also produced 8,000 tons of zinc in concentrate from 1.0% ore and 800 tons of copper from 0.3% ore. Cominco Alaska's Red Dog Mine, about 90 miles north of Kotzebue in northwest Alaska, officially opened in February after some initial startup problems that arose in late 1989. However, operations continued to improve through the year, and the mill processed 904,000 tons of ore, which graded 26.5% zinc, 8.5% lead, and 3.6 troy ounces per short ton of silver. Lead concentrate production was 51,400 tons at 55.1% lead compared with 306,000 tons of zinc concentrate at 56.9% zinc and 3% lead. The mill also produced a bulk concentrate of 45,000 tons grading 31.7% zinc and 22.9% lead. Ultimate average production levels are projected at 70,000 tons of contained lead and 325,000 tons of contained zinc per year from measured reserves of 67 million tons estimated to average 5.4% lead and 18.5% zinc, according to Cominco Ltd.

Insert tables 3-6 here.

Secondary.--Domestic secondary production increased for the fifth consecutive year, setting a new record, as the industry continued to perform at 90% of capacity, estimated to be 1.3 million tons per year at yearend. In spite of the closure, for environmental reasons, of Exide Corp.'s Dixie Metals Co. plant in Dallas, TX, and the Alco Pacific Inc. plant in Carson, CA at yearend, there was a net increase in domestic capacity of about 100,000 tons for the year. This was the result, primarily, of expansions and improvements at several larger plants, mostly by RSR Corp., GNB Inc., and Schuylkill Metals Corp. The latter was acquired by a Citicorp investor group during the year, which allowed for a recapitalization of its two plants. At yearend, the industry was represented by 15 companies that operated 22 battery breakers-smelters with capacities of 6,000 to 110,000 tons per year. Also operating were 6 smaller operations (including Asarco's Omaha, NE refinery and Doe Run's Boss, MO smelter), with plant capacities of 6,000 to 10,000 tons per year that did not process batteries. In addition, 21 small companies with 22 plants of less than 1,000 tons per year of capacity each were producing mainly specialty alloys for such uses as solders, brass or bronze ingots, and bearing metals, etc. Production from the latter two secondary sectors in 1990 combined, excluding Doe Run, was 37,900 tons. Although Doe Run was technically a secondary producer during 1990, its battery scrap was tolled by others, but its "high-grade" scraps and drosses, etc., were processed in the Buick primary plant's blast furnace and kettles at Boss, MO. Therefore, although its production is included in the first category, the "interim" capacity is not. However, work proceeded on a new secondary plant and breaker at Buick during the year after the Homestake buyout and an additional 54,000 tons of secondary capacity was expected to come on-stream in late summer 1991. In Texas, Tejas Resources Inc. started construction at Terrell of a new, conventional 27,000-ton-per-year capacity smelter to process 10,000 batteries per day on a "just-

in-time" basis from offsite breakers. The rotary furnace with wet scrubbers was expected to come onstream in mid-1991, producing a nonleachable sodic slag reportedly safe for conventional landfilling, which is considerably cheaper than disposing of toxic slags.

Insert tables 7-9 here.

Consumption

Reported consumption of lead (tables 10 through 13) was about the same as for 1989, with battery manufacturers again using more than 1 million tons or 79% of the total consumer offtake. Although automotive starting-lighting-ignition (SLI) battery shipments, domestic and export, exceeded 80 million units for the third consecutive year, they were about 300,000 lower than in 1989 (3,000 tons of lead), according to Battery Council International statistics. However, inventories rose by 1.52 million units, accounting for 15,000 tons of increased lead use. Lead use by the industrial-traction battery sector declined slightly, from an estimated 174,000 tons in 1989 to 172,000 tons in 1990; use in all other specialty batteries declined from 43,000 tons (revised) in 1989 to 40,000 tons in 1990. When this 5,000 ton decrease is added to the SLI battery shipments decrease and subtracted from the inventory buildup, the result is the 7,000-ton net increase in total battery lead consumed shown on table 10. It was estimated that small, sealed "consumer battery" cells accounted for 5,000 to 10,000 tons of the specialty battery offtake, which includes nonstandard military and civilian research applications not covered by the SLI (includes aircraft), stationary, or motive power categories. The industrial and traction battery sector includes uninterruptible power supply (UPS) designed to ensure constant voltage for large computer systems at hospitals, banks, communication networks, etc., and standby power supply (SBS) for emergency lighting and some telephone systems. About one-third of the lead total in this category applies to electric vehicles and submarines, including some surface boats, and some in-plant and mine equipment. The whole industrial-traction sector exhibits great potential for continued future growth as networking of computers of all capacities continues to grow and general purpose electric vehicles and customer load-leveling loom ever closer to universal application.

Lead oxides used for glass, paint, ceramics, and other chemicals, which had been the second largest use for lead, declined for the sixth consecutive year. All other uses exhibited marginal increases or decreases, except cable lead, which declined significantly, ostensibly a rationalization of 1989's 40% increase over that of 1988.

Insert tables 10 - 15 here.

World Review

According to the International Lead and Zinc Study Group (ILZSG) statistics, cosumption of soft lead and antimonial lead in the market economy countries (MEC) was 4.44 million tons in 1990, down from the record high of 4.52 million tons set in 1989.[1] Estimated world consumption of lead in all forms decreased

for the first time since 1982, to 5.9 million tons, after setting a record of almost 6.1 million tons in 1989 (table 16). A considerable part of this decline occurred in the U.S.S. R., a result of the year's political and resulting economic turmoil, and in the former Soviet Bloc in general (excluding China and North Korea), where estimated refinery production declined 60,000 tons from that of 1989 (table 19). From 1983, when the world emerged from a previous 3-year recessionary period, through 1989, a continual growth in demand averaging 2.3% per year had occurred. This was attributed to electrical power storage requirements for vehicles and aircraft or ships; emergency standby power for lighting, communication, and computers, including voltage regulation; and load leveling for light manufacturing.

Estimated world total refinery production in 1990, including that from recycled new and old scrap, decreased slightly from 1989's record high as metal stocks increased for the first time in 3 years. A 70,000-ton decrease in primary metal output was partially offset by a record secondary output of more than 2.7 million tons, paced by that sector in the United States that set a domestic secondary production record for the second straight year. The high overall production rate in the face of dwindling world demand from battery manufacturers, who were already sitting on high stocks, resulted in the considerable drop in the world price of lead in the fourth quarter of the year. That was the first significant price decline since the first quarter rationalization in 1989 that reflected high yearend 1988 metal stocks. At yearend, LME physical stocks of lead at 56,400 tons were only 5,000 tons below the high level at yearend 1988. Four new lead-producing mines came on-stream in 1990, two in China and one each in Australia (Thalanga) and Canada (Estrades). Although there was a net capacity increase for the year, there were six closures owing to depletion of ore. However, as a result of numerous other expansions and/or facility upgrades, the only net capacity decreases were in Greenland, whose only mine closed in midyear; Japan; Spain; and Yugoslavia. The largest capacity increase by far was in the United States, which reflected the official opening of Cominco Alaska's Red Dog Mine. The largest expansion was MIM Holdings Ltd.'s (MIM) Hilton Mine (10,000 tons), which in 1989 was integrated into the Mount Isa complex in Queensland, Australia. Although Nuova Samim brought its large primary plant at Porto Vesme, Sardinia, back on-stream in midyear with a capacity increase after being shut down for 11 months, permanent closures in Greece, South Korea, and Yugoslavia resulted in an insignificant net loss of smelter capacity worldwide (table 17).

Insert tables 16-19 here.

Australia.--The Pancontinental-Outokumpu-Agip partnership started the Thalanga open pit in Queensland and continued development of the underground mine, expected to be in production in 1991 and eventually to replace the surface operation. Also in Queensland, MIM continued construction of its new, patented, 60,000-metric-ton-per-year Isasmelt plant scheduled to open in 1991. In New South Wales (NSW), Denehurst Ltd. continued development of the Currawong deposit, a satellite ore body to its Woodlawn open pit mine, expected to be operational in 1991 at a rate of 3,000 tons of lead per year. Reserves were estimated at 500,000 tons of complex base and precious-metal ore

grading more than 13% lead. At Broken Hill, NSW, Pasminco Ltd. announced a modernization program to reduce mining and milling costs by 25% to 30% at its ZC Mine by increasing throughput from an additional 7-million-ton ore body to 2.5 million tons per year grading 8% lead and 10% zinc by 1992-93. At the Silver King project, near Mount Isa, Diversified Resources announced a preliminary reserve estimate of 712,000 tons grading 0.48% lead and 4.94% zinc. Enterprise Metals, a wholly owned subsidiary of CRA Ltd., announced a decision to develop the Peak Gold project in NSW near its Cobar Mine. The deposit reserves were estimated to be 3.9 million tons grading 1.3% and 1.5%, respectively, for lead and zinc. CRA also announced the discovery of a potentially significant ore body, amenable to open pit mining, estimated to be about 70 million tons grading 1% lead and 7% zinc approximately 250 kilometers northwest of Mount Isa. MIM acquired a 50% share of Metallgesellschaft's ISF plant at Duisburg in the Federal Republic of Germany, to which they already ship some of the bulk concentrates produced at Mount Isa. Denehurst Ltd. revised reserve estimates for its base and precious-metals open pit mine in NSW to 3.58 million tons grading 2.4% lead, in effect extending its life for an additional 10 years.

Austria.--BBU-Metalle completed expansion and modernization of its 1963 round hearth, secondary smelter at Arnoldstein and installed a state-of-the-art Tonolli CX battery breaking system. Capacity was increased from 8,000 tons per year to 32,000 tons per year.

Canada.--Breakwater Resources Ltd. opened the country's only new lead producer in 1990, the underground Estrades Mine, primarily a zinc and copper mine, near Joutel, Quebec; the ore was milled at Noranda's Mattagami facility. Estrades' reserves were estimated to be 941,400 tons grading 10.7% zinc, 0.94% copper, and 0.92% lead. During the year, Breakwater also acquired all of the shares of Bathhurst Metals and its Caribou Mine in New Brunswick, but shut Caribou down in October rather than revamp the mill and further develop the mine to increase output, preferring to concentrate on its Estrades Mine and El Mochito Mine (Honduras) instead. Westminer Canada, a wholly owned affiliate of Western Mining of Australia, brought the Gays River underground mine in Nova Scotia, closed since 1981, back on-stream with an expected capacity of about 10,000 tons per year from ore grading about 4.5% lead. Curragh Resources completed a development plan for its Mount Hundere project in the Yukon Territory, estimating reserves of 3.94 million tons grading 4.1% lead and 12.8% zinc. The production plan was for 50,000 tons per year of 73% lead concentrate. Construction work on the mill and tailings dam began after the issuance of a C$130 million bond issue and negotiation of a C$55 million financing package for mine development. The mine was expected to come on-stream in late 1991 or early 1992. In northern British Columbia, Curragh continued to develop the huge Cirque deposit, planned for 1992 startup. Reserves were estimated to be 13 million tons of 14% combined lead and zinc with a lower grade reserve base of an additional 20 million tons. Development continued at Curragh's Vangorda and Grum deposits in the Yukon, planned open pits intended to maintain the nearby Faro Mine and mill production levels of 120,000 tons per year of lead and 200,000 tons per year of zinc when that operation begins to tail off in 1991.

Canadian metal production suffered during the year when the labor force struck the Bathurst Mining and Smelting Co.'s smelter-refinery from July 22 through yearend; management continued to operate the facility at only 25% of capacity. There was no settlement by yearend when the company retracted its "final" offer. Also affecting production was Cominco Ltd.'s decision to shut down and reevaluate its new, in 1989, 160,000-ton-per-year QSL smelter at Trail, British Columbia in March owing to feed process and mechanical problems. Lead production continued at about 80% of the old smelter capacity of 125,000 tons per year through yearend. The company had closed its Trail "feeder" in British Columbia, the Sullivan Mine at Kimberley, in January, but reopened it in November after the completion of a C$11 million development program. The new smelter, however, was not expected to reopen until well into 1991, or later if major design modifications became necessary.

France.--Berzelius (Federal Republic of Germany) and Société de Traitements Chimiques des Metaux (STCM) signed a cooperative agreement on developing environmental technology for secondary lead plants, with the former to acquire a minority interest in the latter. Berzelius' secondary plant at Braubach, Federal Republic of Germany, has a capacity of 45,000 tons per year, while STCM's two plants in France total 50,000 tons per year capacity. Ste. GAST started construction of a new secondary plant, 20,000-ton-per-year capacity, to open in 1991 at Brenoville, Pont Ste. Maxence.

Germany, Federal Republic of.--Berzelius Metallhütten GmbH, the operating arm of Metallgesellschaft, opened the new QSL plant at Stolberg (Binsfeldhammer) late in the year. Rated at a capacity of 100,000 tons per year, it replaced an existing smelter rated at 80,000 tons per year. Earlier in the year Metallgesellschaft had signed an agreement with the State-owned Eastern State company BHKF for replacement of its Freiberg smelter with a QSL plant. Berzelius also completed plans to modify and expand its ISF plant at Duisburg, which can process both primary and secondary material, by mid-1991. MIM was buying a 50% stake in that plant in order to increase its involvement worldwide in metal production; it already ships some of the bulk concentrates from its Mount Isa Mine in Queensland to Duisburg.

Honduras.--American Pacific Mining, a wholly owned U.S. subsidiary of Breakwater Resources Ltd. (Canada), continued upgrading the access and haulage systems at the El Mochito Mine in order to be more selective and yield higher average-grade ores. They also completed a new tailings facility to extend the mine's life at least 10 years. Breakwater assumed full control in April and planned to continue exploration to extend the ore bodies and raise mill throughput to 2,000 tons per day in 1991. Ore reserves were estimated to be 5.5 million tons grading 1.6% lead and 6.85% zinc.

India.--Hindustan Zinc Co. Ltd. continued development of its open pit at Rampura-Agucha, Rajasthan, expected to open in 1991 and to be producing 8,000 tons per year of lead by 1992. The company continued on schedule with construction of its new ISF servicing smelter at Chanderiya, Rajasthan, expected to start up in mid-1991 and reach capacity of 35,000 tons per year in 1993. About 40% of the feed was expected to come from Rampura-Agucha and Hindustan's underground Ambamata Mine at Gujrat, also under development, and

more than one-half to be imported, with zinc capacity estimated at 70,000 tons per year. A new secondary plant, expected to open in 1991 at 6,000-ton-per-year capacity, was under construction on the west coast by the Rohit Pulp and Paper Mills Co.

Iran.--Four active mines were undergoing expansion projects to yield an additional total capacity of 18,000 tons per year between 1991 and 1994. These mines, Angouran open pit in the north at Zandjan, Emarat open pit at Khomain in the central province of Esphahan, Ahangzan open pit at Hamadaz in the west, and Nakhlak underground at Yazd in central Iran, were expected to reach full production in that phasing order.

Ireland.--Conroy Petroleum Ltd. completed the feasibility study for its proposed Galmoy Mine and reportedly estimated reserves at 6.2 million tons grading 11.31% zinc and 1.12% lead. The company applied for permits to develop the underground ore body through a 13% surface decline ramp and planned to produce 2,000 to 5,000 tons per year of lead starting in 1992 or 1993. Tara Mines Ltd. was in the process of completely upgrading the equipment for its underground mine at Navan, County Meath, in order to reach the original planned production of 38,000 tons of lead per year by 1991 or 1992.

Korea, Republic of.--Korea Zinc Co. Ltd. neared completion of its new 80,000-ton-per-year QSL smelter and refinery at Onsan, on schedule to open in 1991. Korea Mining and Smelting Co. Ltd. closed its 15,000-ton-per-year primary smelter and refinery at Changhang, a result of insurmountable environmental problems.

Malaysia.--Metals Reclamation Industrial Snd. Bhd. started a plant relocation and capacity upgrade from 16,000 to 24,000 tons per year at its secondary plant at Selayang, to be fully operational by 1992.

Pakistan.--Additional lead-zinc deposits were discovered and evaluated in the Baluchistan region, where previous explorations had identified a 10-million-ton ore body near Khudzar. One at Duddar was estimated to contain 0.66 million tons grading about 3% lead and 15.5% zinc. Another at Surmain was estimated to contain 2.93 million tons grading 6.5% combined lead-zinc.

United Kingdom.--Britannia Refined Metals, a wholly owned subsidiary of MIM, neared completion of its new 40,000-ton-per-year secondary Isasmelt furnace and refinery, scheduled to replace the 10,000-ton-per-year conventional plant by mid-1991. The new complex at Northfleet, Kent, will also have a state-of-the-art Tonolli CX battery breaking system, which was being installed by Engitec Impianti of Italy. Anglesey Mining Ltd., a subsidiary of Imperial Metals Corp., initiated shaft sinking at its planned Parys Mountain underground mine in North Wales. Bulk sampling was initiated to further evaluate the deposit, for which the preliminary estimate was that it could be producing 300,000 tons per year of ore, primarily zinc and copper ore but containing about 5,000 tons of lead, by 1992 or 1993.

Yugoslavia.--At yearend, Ro Rudniki Svinca in Topilnica closed its 26,000-ton-per-year primary smelter at Mezica, Slovenia, which had been producing refined lead since 1906. The company also started closure of the plant's captive mine at the same location, to be completed in stages by 1995. SOUR Hemijska Industrija completed closure of its Brskovo Mine at Mojkovac, Montenegro, a process started in 1987. The closures are to be more than offset by Zletovo-Sasa's 10,000-ton-per-year expansion project underway at its Toranica Mine and Zorka-Sabac's 2,000-ton-per-year expansion project underway at its mine at Sastavci-Kizevac. Both underground mines were expected to be at full capacity by 1992.

Current Research

In recent years, research in lead use worldwide has focused strongly on improvements to the lead-acid battery, through all its applications, in terms of safety, capacity, longevity, durability, dependability, and manufacturing-marketing economics, including plant robotics. In 1990, two researchers at Caltech, under contract to NASA, discovered one potential solution to overcoming the most common failure mode in deep drawdown cycle applications, paste softening and, therefore, accelerated disintegration of the positive plate. As the active material paste slakes, the whole cell can become inactive, or the paste can fall to the bottom and short against the negative plate. Exposure of the grid can then lead to abnormal corrosion, producing an insulating layer and higher resistance. The softening can also be manifested by grid "growth" (bulking) causing separation of the positive active paste, causing loss of capacity and leading to premature, but not immediate, failure. Together with overall lowered conductivity, plate utilization during discharge is also reduced. The solution discovered was to mix randomly oriented, very thin and short, lead-coated glass fibers into the paste prior to grid application, which also improved the structural integrity of the plate upon curing. The compatible conductive fibers increase charge uniformity of the plate, preventing electrical isolation and improving paste utilization during discharge. Fibers 0.004 inch thick coated to 0.010 inch thick and cut to 0.100 inch in length displace about 2% of the lead monoxide paste volume. The approximate 5% weight gain is then offset by increasing grid spacing. Because the lead on the fiber is also charged during formation of the battery, a more thorough electrical and mechanical interface with the active material is established without any loss of structural integrity.[2]

One of the most novel, recently developed uses of lead with continuing developmental applications is for building foundations isolated against severe horizontal earthquake acceleration "shocks." Because of lead's unique softness and density properties, it is ideal for use in dampers under midrise buildings of about four to six stories in commonly severe earthquake-prone areas where the common shock frequency of horizontal accelerations is between 1 and 2 seconds, which is about the resonant frequency of such structures. Harmonic attenuation causes these buildings to shake themselves apart under such conditions. Base-isolation systems commonly consist of large steel springs to support the building weight, dampened by steel-rubber "sandwiches." However, laboratory testing of several cast-lead shapes on computer-driven shaking tables has proven conclusively that lead dampers absorb significantly

greater amounts of energy per cycle. Each U-shaped damper, determined to be the optimal form in this application, weighs 132 pounds and can dampen 121 square feet of ground floor in a typical midrise structure. This method for earthquake protection has been accepted by the Japan Institute of Architects, and a 500-page design and construction manual has been written. Two prototype buildings in Japan which are currently being monitored, were recently completed. At yearend, several other buildings were being planned in Japan, including two office buildings, one of which called for a critical computer facility on the top floor that cannot tolerate disruptions.[3]

A comprehensive coverage of lead-related investigations and an extensive review of current world literature on the extraction and uses of lead and its products, including batteries, were published in quarterly issues of Leadscan, published by the Lead Development Association, London, United Kingdom.

OUTLOOK

Although domestic demand for lead grew on average about 4% per year from 1985 to 1989 (table 2), this rate cannot be sustained in the future because some end uses of lead will certainly be curtailed or eliminated entirely by legislation or regulation. One of the current pollution prevention strategies, known as source reduction, will probably reduce the use of lead in nongrowth markets such as solders, paints, and coatings (already eliminated in interior house paints), ceramics, gasoline additives, containers or other packaging (including inks or dyes, especially where food is concerned), and cosmetics. Some reduction of lead per battery unit can also be anticipated as the technology continues to advance. As a result, U.S. annual growth in lead demand will probably fall within a range of 0.5% to 1.5% per year in the decade of the 90's, averaging about 1%, as the storage battery sector becomes even more dominant. The lower growth rate can certainly be expected if source reduction is applied to the ammunition sector, currently the second largest end use. The higher growth rate could be attained if the use of lead-acid batteries for peak-power, load-leveling applications becomes widely accepted for households and commercial facilities, and/or there is a moderate demand for private general purpose electric cars. The latter two conditions will probably not prevail until the end of the century.

World demand for lead grew at an average rate of more than 2% through 1989 from the low recession year of 1982 (table 16). Lower growth U.S. demand, which is currently 22% of the total, will undoubtedly lower the overall world growth rate somewhat in the future. However, storage battery use in all applications will undoubtedly grow faster in the rest of the world than in the United States as some poorer nations increase their living standards while they grow with the world economy. It is estimated that currently about 60% of world demand is for batteries, compared with about 80% in the United States, and is forecast to reach about 70% by the end of the decade as the rest of the world's supply-demand pattern is rationalized by environmental concerns. Therefore, the most probable world growth until the end of the century is forecast to average about 1.5% per year.

The attendant worldwide production outlook is interrelated with anticipated structural changes. Because of large capital demand and high costs associated with environmental concerns, large production surpluses in the near term are

not likely. High realized producer prices are critical to profitably amortizing the large improvement expenditures anticipated over the next 10 years. However, this will continue to be partially subjected to developing situations in zinc and silver markets because of the geologic relationships of the three metals in the primary production sector. The trend of increasing secondary share of production and consumption exhibited on tables 19 and 16, respectively, is expected to continue until optimum recycling is achieved. Complex multinational, multifaceted realignments and restructuring, including divestitures, among world lead producers and product manufacturers are expected to continue through the rest of the century. Most noticeable will be investments of primary producers, in many cases through acquisitions and mergers, in secondary lead production to protect existing market share.[4]

1/International Lead and Zinc Study Group (London). Lead and Zinc Statistics. Monthly Bull., v. 32, No. 3, Mar. 1992.

2/National Aeronautics and Space Administration Contract No. NAS 7-918. NASA Tech Briefs, v. 15, No. 1, Jan. 1991, p. 20.

3/Goodwin, F.E., Vice Pres., International Lead-Zinc Research Organization, Inc. (ILZRO), Research Triangle Park, NC. New Opportunities for Lead. Presentation at 63d Annual Lead Industry Association Meeting., Apr. 25, 1991, Washington, DC.

Takayama, M., A. Wada, H. Akiyama, and H. Tada. Feasibility Study on Base-Isolated Buildings. Paper in Proceedings of Ninth World Conference on Earthquake Engineering. Tokyo-Kyoto, Japan, v. 5, 1988, p. 669.

4/Woodbury, W. Lead. Ch. in BuMines Minerals Yearbook, 1989.

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Insert tables 20-27 here.

TABLE 1

SALIENT LEAD STATISTICS

(Metric tons unless otherwise specified)

	1986	1987	1988	1989	1990
United States:					
Production:					
Domestic ores, recoverable lead content	339,793	311,381	384,983	410,915	473,992
Value ----------thousands	$165,150	$246,720	$315,222	$356,476	$480,917
Primary lead (refined):					
From domestic ores and base bullion	348,217	336,471	371,348	379,034	385,637
From foreign ores and base bullion	22,071	37,139	20,739	17,421	18,020
Secondary lead (lead content)	624,769	710,067	736,401	r/891,341	922,911
Exports (lead content):					
Lead ore and concentrates	4,380	8,764	20,902	1/57,038	1/56,600
Lead materials, excluding scrap	19,778	13,586	29,077	1/43,837	1/76,749
Imports for consumption:					
Lead in ore and concentrates	4,604	873	20,606	r/1/2,939	1/7,790
Lead in base bullion	142	10,827	4,046	1/5,782	1/2,713
Lead in pigs, bars,, reclaimed scrap	143,511	192,260	155,893	1/116,358	1/90,919
Stocks, Dec. 31:					
Primary lead2/	20,400	21,608	15,398	15,623	25,525
At consumers and secondary smelters	83,824	88,586	89,865	r/82,355	86,503
Consumption of metal, primary and secondary	1,125,521	1,230,373	1,245,170	r/1,277,604	1,275,233
Price: Metals Week average, delivered, cents per pound	$22.05	$35.94	$37.14	$39.35	$46.02
World:					
Production:					
Mine ----------thousand metric tons	r/3,345.2	r/3,424.6	3,429.8	p/3,367.8	e/3,367.2
Refinery3/ ----------do.	r/3,190.9	r/3,193.7	3,246.0	p/3,284.5	e/3,214.0
Secondary refinery ----------do.	r/2,360.5	r/2,524.1	2,604.4	p/2,702.1	e/2,727.7
Price: London Metal Exchange, pure lead, cash average, cents per pound	$18.43	$26.99	$29.73	$30.63	$37.05

e/Estimated. p/Preliminary. r/Revised.

1/Because of the implementation of the Harmonized Tariff System in Jan. 1989, import and export categories for 1989 and 1990 are not necessarily comparable with those in previous years.

2/American Bureau of Metal Statistics Inc.

3/Primary metal production only. Includes secondary metal production where inseparably included in country total.

385,637
18,020
403,657

TABLE 2

LEAD SUPPLY-DEMAND RELATIONSHIPS1/

(Thousand metric tons)

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
Mine production (Pb in concentrates):														
United States	240	270	285	310	300	340	480	540	545	585	570	625	587	576
Rest of world	2,285	2,260	2,415	2,550	2,580	2,680	2,775	2,875	2,875	2,815	2,940	2,815	2,868	2,792
Total	2,525	2,530	2,700	2,860	2,880	3,020	3,255	3,415	3,420	3,400	3,510	3,440	3,455	3,368
COMPONENTS AND DISTRIBUTION OF U.S. SUPPLY														
Components of U.S. supply:														
Refinery production:														
Domestic ore	226	275	283	299	243	334	481	489	534	531	527	535	483	520
Foreign ore	141	141	103	111	110	107	113	126	70	94	97	85	96	76
Old scrap	e/424	426	450	440	433	428	468	459	444	452	489	545	512	564
Imports--Metal, excluding scrap	202	193	202	260	331	307	253	222	175	223	162	107	90	129
Industry stocks, Jan. 1, pigs and bars	214	160	137	122	102	117	85	138	210	161	166	136	185	195
Government stockpile releases	4	36	49	58	25	26	20	11	9	41	191	241	6	--
Total U.S. supply	e/1,211	1,231	1,224	1,290	1,244	1,319	1,420	1,445	1,442	1,502	1,632	1,649	1,372	1,484
Distribution of U.S. supply:														
Industry stocks, Dec. 31, pigs and bars	160	137	122	102	117	85	138	210	161	166	136	185	195	157
Exports--Metal, excluding scrap	1	9	7	5	6	8	4	7	5	8	60	56	19	5
Industrial demand	e/1,050	1,085	1,095	1,183	1,121	1,226	1,278	1,228	1,276	1,328	1,436	1,408	1,158	1,322
U.S. DEMAND PATTERN														
Ammunition	45	51	52	71	71	75	72	66	79	77	74	79	68	67
Construction	130	131	122	118	108	112	105	90	90	80	79	69	63	65
Electrical	78	80	84	93	88	85	84	80	117	116	122	120	70	75
Gasoline additives	175	203	204	225	225	238	246	253	240	253	249	227	189	218
Oxides and chemicals	90	94	99	109	94	100	93	90	74	82	100	106	72	96
Transportation	440	430	430	460	440	520	580	560	590	630	720	715	625	705
Other	92	96	104	107	95	96	98	89	86	90	92	92	71	96
Total U.S. demand	e/1,050	1,085	1,095	1,183	1,121	1,226	1,278	1,228	1,276	1,328	1,436	1,408	1,158	1,322
Total U.S. primary demand (Industrial demand less old scrap)	626	659	645	743	688	798	810	769	832	876	947	863	646	758
PRICES														
Average annual (cents per pound)	11.1	13.6	16.0	15.2	14.0	13.2	14.9	15.7	13.9	15.0	16.3	22.5	21.5	23.1
Average annual, based on constant 1987 dollars, (cents per pound)	40.4	48.6	55.7	50.9	45.9	41.3	44.1	44.0	36.8	38.0	38.8	49.1	42.6	43.2

See footnotes at end of table.

TABLE 2--Continued

LEAD SUPPLY-DEMAND RELATIONSHIPS1/

(Thousand metric tons)

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989p/	1990e/
Mine production (Pb in concentrates):														
United States	560	552	547	573	459	530	466	335	424	353	319	394	420	495
Rest of world	2,808	2,843	2,925	2,897	2,907	2,918	2,891	2,934	3,007	2,992	3,106	3,036	2,948	2,872
Total	3,368	3,395	3,472	3,470	3,366	3,448	3,357	3,269	3,431	3,345	3,425	3,430	3,368	3,367
COMPONENTS AND DISTRIBUTION OF U.S. SUPPLY														
Components of U.S. supply:														
Refinery production:														
Domestic ore	490	504	532	509	443	465	464	324	423	348	336	371	379	386
Foreign ore	62	64	46	39	55	52	55	65	71	22	37	21	17	18
Old scrap	637	650	673	581	578	521	452	586	570	575	658	691	842	874
Imports--Metal, excluding scrap	231	227	183	82	100	95	177	163	133	142	188	152	122	97
Industry stocks, Jan. 1, pigs and bars	157	135	143	199	181	203	171	154	142	178	104	110	105	98
Government stockpile releases	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total U.S. supply	1,577	1,580	1,577	1,410	1,357	1,336	1,319	1,292	1,339	1,265	1,323	1,345	1,465	1,473
Distribution of U.S. supply:														
Industry stocks, Dec. 31, pigs and bars	135	143	199	181	203	171	154	142	178	104	110	105	98	112
Exports--Metal, excluding scrap	9	8	11	164	23	56	20	7	27	13	10	14	34	64
Industrial demand	1,433	1,429	1,367	1,065	1,131	1,109	1,145	1,143	1,134	1,148	1,203	1,226	1,333	1,297
U.S. DEMAND PATTERN														
Ammunition	62	56	53	49	49	44	44	48	50	44	47	53	57	58
Construction	75	60	50	37	37	40	44	43	39	34	31	32	31	34
Electrical	90	88	86	70	74	75	80	93	120	143	138	132	149	143
Gasoline additives	211	178	187	128	111	119	89	79	46	29	W	W	W	W
Oxides and chemicals	91	92	91	78	80	61	69	77	73	70	68	63	58	57
Transportation	795	855	815	640	720	720	770	755	760	785	850	875	980	950
Other	109	100	85	63	60	50	49	48	46	43	69	71	58	55
Total U.S. demand	1,433	1,429	1,367	1,065	1,131	1,109	1,145	1,143	1,134	1,148	1,203	1,226	1,333	1,297
Total U.S. primary demand (Industrial demand less old scrap)	796	779	694	484	553	588	693	557	564	573	545	535	491	423
PRICES														
Average annual (cents per pound)	30.7	33.7	52.7	42.4	36.5	25.5	21.7	25.6	19.1	22.0	35.9	37.1	39.4	46.0
Average annual, based on constant 1987 dollars, (cents per pound)	53.7	54.9	78.9	58.2	45.6	30.1	24.5	27.9	20.2	22.8	35.9	35.9	37.8	44.2

e/Estimated. p/Preliminary. W Withheld to avoid disclosing company proprietary data, included in "Other."
1/1964-83 revised from previous editions of Mineral Facts and Problems.

TABLE 3

MINE PRODUCTION OF RECOVERABLE LEAD IN THE UNITED STATES, BY STATE

(Metric tons)

State	1986	1987	1988	1989	1990
Idaho	9,951	W	W	W	W
Missouri	319,900	W	353,194	366,931	372,383
Montana	W	W	8,266	W	W
Nevada	--	--	W	--	830
New Mexico	10	W	W	W	W
South Dakota	--	--	--	4	--
Total1/	339,793	311,381	384,983	410,915	473,992

W Withheld to avoid disclosing company proprietary data; included in "Total."

1/Includes, for at least some of the years 1986-90, Alaska, Arizona, Colorado, Illinois, New York, and Tennessee.

TABLE 4

MINE PRODUCTION OF RECOVERABLE LEAD
IN THE UNITED STATES, BY MONTH

(Metric tons)

Month	1989	1990
January	33,553	41,556
February	31,323	38,255
March	34,840	39,050
April	33,996	36,619
May	34,885	39,984
June	36,401	38,024
July	33,509	41,432
August	38,992	46,271
September	34,601	37,144
October	35,379	42,116
November	33,116	37,726
December	30,320	35,815
Total	410,915	473,992

TABLE 5

TWENTY-FIVE LEADING LEAD-PRODUCING MINES IN THE UNITED STATES IN 1990, IN ORDER OF OUTPUT

Rank	Mine	County and State	Operator	Source of lead
1	Fletcher	Reynolds, MO	The Doe Run Co.	Lead-zinc ore.
2	Buick	Iron, MO	--- do.	Do.
3	Magmont	--- do.	Cominco American Inc.	Do.
4	West Fork	Reynolds, MO	ASARCO Incorporated	Do.
5	Red Dog	Northwest Arctic, AK	Cominco Alaska Inc.	Zinc ore.
6	Casteel1/	Iron, MO	The Doe Run Co.	Copper-lead ore.
7	Sweetwater	Reynolds, MO	ASARCO Incorporated	Lead-zinc ore.
8	Viburnum No. 29	Washington, MO	The Doe Run Co.	Do.
9	Viburnum No. 28	Iron, MO	--- do.	Copper-lead ore.
10	Lucky Friday	Shoshone, ID	Hecla Mining Co.	Lead-zinc ore.
11	Greens Creek	Admiralty Island, AK	Greens Creek Mining Co.	Zinc ore.
12	Montana Tunnels	Jefferson, MT	Montana Tunnels Mining Inc.	Do.
13	Bunker Hill	Shoshone, ID	Bunker Hill Mining Co. (U.S.) Inc.	Do.
14	Sunnyside	San Juan, CO	San Juan County Mining Venture	Do.
15	Leadville Unit	Lake, CO	ASARCO Incorporated	Lead-zinc ore.
16	Butte Hill	Silver Bow, MT	New Butte Mining Co. Inc.	Do.
17	Balmat	St. Lawrence, NY	Zinc Corporation of America	Zinc ore.
18	Ward/Taylor	White Pine, NV	Alta Gold Co.	Lead-zinc ore.
19	Galena	Shoshone, ID	ASARCO Incorporated	Silver ore.
20	Pierrepont	St. Lawrence, NY	Zinc Corporation of America	Zinc ore.
21	Rosiclare	Hardin and Pope, IL	Ozark-Mahoning Co.	Fluorspar.
22	Franklin	Clear Creek, CO	Franklin Consolidated Mines Inc.	Gold-silver ore.
23	Gies Mine	Fergus, MT	Blue Range Mining Co.	Gold ore.
24	Young	Jefferson, TN	ASARCO Incorporated	Zinc ore.
25	Center	Grant, NM	Mount Royal Mining Co.	Gold ore.

1/Includes Brushy Creek Mill.

TABLE 6

REFINED LEAD PRODUCED AT PRIMARY REFINERIES IN THE UNITED STATES, BY SOURCE MATERIAL1/

(Metric tons unless otherwise specified)

Source material	1986	1987	1988	1989	1990
Refined lead:					
Domestic ores and base bullion	348,217	336,471	371,348	379,034	385,637
Foreign ores and base bullion	22,071	37,139	20,739	17,421	18,020
Total	370,288	373,610	392,087	396,455	403,657
Calculated value of primary refined lead2/--thousands	$180,004	$296,026	$321,039	$343,932	$409,537

1/Total refined lead: American Bureau of Metal Statistics Inc.; domestic and foreign ores: U.S. Bureau of Mines calculations.

2/Value based on average quoted price.

TABLE 7

STOCKS AND CONSUMPTION OF NEW AND OLD LEAD SCRAP IN THE UNITED STATES, BY TYPE OF SCRAP

(Metric tons, gross weight)

Type of scrap	Stocks, Jan. 1	Receipts	Consumption			Stocks, Dec. 31/
			New scrap	Old scrap	Total	
1989r/						
Smelters, refiners, others:						
Soft lead2/	1,682	31,260	--	31,914	31,914	1,028
Hard lead	191	8,616	--	8,616	8,616	191
Cable lead	885	11,372	--	11,237	11,237	1,021
Battery-lead	21,457	997,269	--	994,301	994,301	24,425
Mixed common babbitt	115	2,071	--	1,990	1,990	196
Solder and tinny lead	2,212	19,680	--	20,057	20,057	1,835
Type metals	103	1,803	--	1,800	1,800	106
Drosses and residues	4,045	64,983	66,847	490	67,337	1,692
Total1/	30,690	1,137,057	66,847	1,070,406	1,137,253	30,494
1990						
Smelters, refiners, others:						
Soft lead2/	1,028	29,622	--	29,259	29,259	1,392
Hard lead	191	7,115	--	6,526	6,526	780
Cable lead	1,021	15,890	--	15,750	15,750	1,161
Battery-lead	24,425	1,030,768	--	1,032,199	1,032,199	22,994
Mixed common babbitt	196	748	--	752	752	192
Solder and tinny lead	1,835	31,087	--	31,110	31,110	1,812
Type metals	106	4,601	--	4,618	4,618	90
Drosses and residues	1,692	62,824	61,902	958	62,860	1,655
Total1/	30,494	1,182,655	61,902	1,121,171	1,183,073	30,077

r/Revised.

1/Data may not add to totals shown because of independent rounding.

2/Includes remelt lead from cable sheathing plus other soft lead scrap processing.

TABLE 8

SECONDARY METAL RECOVERED1/ FROM LEAD AND TIN SCRAP IN THE UNITED STATES

(Metric tons)

	Lead	Tin	Antimony	Other	Total2/
1989r/					
Refined pig lead3/	438,013	--	--	--	438,013
Refined pig tin4/	--	563	--	--	563
Lead and tin alloys:					
Antimonial lead	418,584	967	14,714	740	435,005
Lead-base babbitt	1,523	116	178	(5/)	1,817
Solder	16,732	3,225	128	(5/)	20,085
Type metal	936	46	137	(5/)	1,119
Other alloys, including cable lead	2,141	30	9	--	2,180
Total2/	439,918	4,384	15,166	740	460,208
Tin content of chemical products	--	W	--	--	W
Grand total2/	877,931	4,947	15,166	740	898,784
1990					
Refined pig lead3/	461,868	--	--	--	461,868
Refined pig tin4/	--	186	--	--	186
Lead and tin alloys:					
Antimonial lead	425,979	742	15,032	737	442,489
Lead-base babbitt	530	28	57	(5/)	615
Solder	(6/)	2,876	126	(5/)	3,002
Type metal	868	46	122	4	1,040
Other alloys, including cable lead	17,778	36	3	--	17,817
Total2/	445,154	3,729	15,340	740	464,962
Tin content of chemical products	--	33	--	--	33
Grand total2/	907,022	3,946	15,340	740	927,048

r/Revised. W Withheld to avoid disclosing company proprietary data.
1/Most of the figures herein represent actual reported recovery of metal from scrap.
2/Data may not add to totals shown because of independent rounding.
3/Includes remelt lead.
4/Includes remelt tin.
5/Included with "Antimony" to avoid disclosing company proprietary data.
6/Included with "Other alloys, including cable lead" to avoid disclosing company proprietary data.

TABLE 9

LEAD RECOVERED FROM SCRAP PROCESSED IN THE UNITED STATES, BY KIND OF SCRAP AND FORM OF RECOVERY

(Metric tons)

	1989r/	1990
Kind of scrap		
New scrap:		
Lead-base	46,715	43,608
Copper-base	2,894	e/5,000
Tin-base	3	4
Total	49,612	48,612
Old scrap:		
Battery-lead	761,279	783,860
All other lead-base	69,644	79,439
Copper-base	10,806	e/11,000
Tin-base	--	--
Total	841,729	874,299
Grand total	891,341	922,911
Form of recovery		
As soft lead	438,013	461,868
In antimonial lead	418,584	425,979
In other lead alloys	21,040	19,060
In copper-base alloys	13,701	e/16,000
In tin-base alloys	3	4
Total	891,341	922,911
Value1/ ----------thousands----------	$773,254	$936,354

e/Estimated. r/Revised.

1/Value based on average quoted price of common lead.

TABLE 10

U.S. CONSUMPTION OF LEAD, BY PRODUCT

(Metric tons)

SIC Code	Product	1989	1990
	Metal products:		
3482	Ammunition: Shot and bullets	r/57,310	58,210
	Bearing metals:		
35	Machinery except electrical	W	W
36	Electrical and electronic equipment	W	199
371	Motor vehicles and equipment	1,683	W
37	Other transportation equipment	W	W
	Total bearing metals	2,586	2,878
3351	Brass and bronze: Billets and ingots	9,610	9,943
36	Cable covering: Power and communication	22,605	18,253
15	Calking lead: Building construction	1,831	1,688
	Casting metals:		
36	Electrical machinery and equipment	524	538
371	Motor vehicles and equipment	W	W
37	Other transportation equipment	3,395	1,996
3443	Nuclear radiation shielding	W	W
	Total casting metals	16,175	14,843
	Pipes, traps, other extruded products:		
15	Building construction	8,856	9,281
3443	Storage tanks, process vessels, etc.	962	(1/)
	Total pipes, traps, other extruded products	9,818	9,281
	Sheet lead:		
15	Building construction	15,900	17,534
3443	Storage tanks, process vessels, etc.	(1/)	(1/)
3693	Medical radiation shielding	5,087	3,479
	Total sheet lead	20,987	21,013
	Solder:		
15	Building construction	3,909	4,472
341	Metal cans and shipping containers	762	552
367	Electronic components and accessories	4,092	4,040
36	Other electrical machinery and equipment	2,029	1,737
371	Motor vehicles and equipment	6,217	5,688
	Total solder	17,009	2/16,490
	Storage batteries:		
3691	Storage battery grids, post, etc.	552,308	571,187
3691	Storage battery oxides	459,847	448,450
	Total storage batteries	1,012,155	1,019,637
371	Terne metal: Motor vehicles and equipment	2,286	2,341
27	Type metal: Printing and allied industries	(3/)	(3/)
34	Other metal products4/	4,564	3,812
	Total metal products	2/1,176,937	2/1,178,388
	Other oxides:		
285	Paint	W	W
32	Glass and ceramics products	W	W
28	Other pigments and chemicals	10,074	13,500
	Total other oxides	57,984	56,484
2911	Gasoline additives	(5/)	(5/)
	Miscellaneous uses	42,684	40,361
	Grand total	2/1,277,604	2/1,275,233

r/Revised. W Withheld to avoid disclosing company proprietary data; included in appropriate totals.
1/Included with "Building construction" to avoid disclosing company proprietary data.
2/Data do not add to total shown because of independent rounding.
3/Included with "Other metal products" to avoid disclosing company proprietary data.
4/Includes lead consumed in foil, collapsible tubes, annealing, galvanizing, plating, and fishing weights.
5/Included with "Miscellaneous uses" to avoid disclosing company proprietary data.

TABLE 11

U.S. CONSUMPTION OF LEAD, BY MONTH1/

(Metric tons)

Month	1989r/	1990
January	111,003	107,331
February	103,556	108,221
March	106,492	114,093
April	104,443	102,628
May	107,677	107,788
June	106,883	104,627
July	98,419	98,715
August	110,839	114,138
September	107,063	106,059
October	114,441	113,796
November	107,865	105,228
December	98,923	92,609
Total2/	1,277,604	1,275,233

r/Revised.
1/Monthly totals include monthly reported consumption plus the prorated monthly distribution for companies that report on an annual basis only.
2/Includes lead that went directly from scrap to fabricated products.

TABLE 12

U.S. CONSUMPTION OF LEAD IN 1990, BY STATE1/

(Metric tons)

State	Refined soft lead	Lead in antimonial lead	Lead in alloys	Lead in copper-base scrap	Total2/
Arizona and California	42,840	32,057	6,506	--	81,402
Florida	3,871	5,818	--	--	9,689
Georgia	33,600	6,380	1,784	--	41,763
Illinois	29,474	41,055	1,124	915	72,568
Michigan	16,152	10,903	510	--	27,563
Missouri	11,102	16,487	--	--	27,588
Ohio	23,437	11,827	2,542	267	38,073
Pennsylvania	87,460	33,229	34,642	574	155,903
Texas	93,624	18,800	8,515	--	120,940
Alabama, Louisiana, Mississippi Arkansas and Oklahoma	26,073	19,929	10,353	2,566	58,921
Delaware and New Jersey	45,204	6,903	2,669	280	55,057
Indiana, Kansas, Kentucky, Tennessee	258,579	65,184	35,270	599	359,632
North Carolina and South Carolina	44,823	30,406	10,820	--	86,048
Connecticut, Massachusetts, Rhode Island	4,475	17	--	--	4,492
District of Columbia, Maryland, Virginia, West Virginia	149	--	7	--	156
Idaho, Oregon, Washington	13,681	7,511	2,177	1,330	24,698
Maine, New Hampshire, New York, Vermont	23,462	10,862	8,420	19	42,761
Iowa, Minnesota, Nebraska, Wisconsin	25,144	27,932	14,237	666	67,978
Total2/	783,147	345,297	139,573	7,216	1,275,233

1/Includes lead that went directly from scrap to fabricated products.
2/Data may not add to totals shown because of independent rounding.

TABLE 13

U.S. CONSUMPTION OF LEAD IN 1990, BY CLASS OF PRODUCT1/

(Metric tons)

Product	Soft lead	Lead in antimonial lead	Lead in alloys	Lead in copper-base scrap	Total
Metal products	66,523	64,617	20,395	7,216	158,751
Storage batteries	624,241	279,571	115,825	--	1,019,637
Other oxides	56,484	--	--	--	56,484
Miscellaneous2/	35,899	1,109	3,353	--	40,361
Total	783,147	345,297	139,573	7,216	3/1,275,233

1/Includes lead that went directly from scrap to fabricated products.
2/Includes gasoline additives to avoid disclosing company proprietary data.
3/Data do not add to total shown because of independent rounding.

TABLE 14

STOCKS OF LEAD AT CONSUMERS AND SECONDARY SMELTERS IN THE UNITED STATES, DECEMBER 31

(Metric tons, lead content)

Year	Refined soft lead	Lead in antimonial lead	Lead in alloys	Lead in copper-base scrap	Total
1986	47,589	30,442	5,524	269	83,824
1987	55,278	27,959	5,185	164	88,586
1988	50,850	34,108	4,756	151	89,865
1989r/	48,592	28,960	4,564	239	82,355
1990	46,096	35,079	5,109	219	86,503

r/Revised.

TABLE 15

AVERAGE MONTHLY AND ANNUAL QUOTED PRICES OF LEAD1/

(Cents per pound)

Month	1989		1990	
	North American producer price	London Metal Exchange	North American producer price	London Metal Exchange
January	40.17	30.62	39.81	32.08
February	37.01	28.17	41.84	35.31
March	35.07	26.69	54.11	48.05
April	35.02	27.55	48.73	37.86
May	36.34	29.15	45.21	37.41
June	39.15	30.16	45.16	37.98
July	40.29	31.32	50.13	39.67
August	41.75	31.81	50.36	39.70
September	43.63	33.00	49.47	38.00
October	43.63	34.07	46.15	34.47
November	41.26	31.39	42.75	31.77
December	38.89	32.22	38.52	28.30
Average	39.35	30.63	46.02	37.05

1/Metals Week. Quotations for the United States on a nationwide, delivered basis. LME cash average.

TABLE 16

WORLD LEAD SUPPLY AND DEMAND

(Thousand metric tons)

Year	Mine production	Primary demand1/	Apparent consumption	Stock changes (ILZSG)	Refinery production	Production surplus/deficit
1978	r/3,391		5,595	-71	5,524	
1979	r/3,468		5,650	+62	5,712	
1980	3,470	60%	5,364	+66	5,430	+91
1981	3,366		5,337	-7	5,330	
1982	r/3,446		5,174	+41	5,215	
1983	r/3,353		5,303	-19	5,284	
1984	3,269		5,582	-113	5,469	
1985	3,431	57.3%	5,587	+54	5,641	
1986	3,345		5,603	-52	5,551	
1987	r/3,352		r/5,685	+37	r/5,722	-186
1988	r/3,359		r/5,833	-17	r/5,816	
1989	r/3,285		r/6,048	-76	r/5,972	
1990	r/3,390	54.5%	r/5,785	+45	r/5,830	+85
1991e/	3,318		5,602	+40	5,642	
Total	47,243	57.5%	78,148	-10	78,138	2/-10

2.25% per year average growth

e/Estimated. r/Revised.
1/Recoverable content (95%) of mine production (lead in concentrate) divided by apparent consumption.
2/Yearend stocks 1977=468; yearend stocks 1991=458 (estimated; producer, consumer, merchant, LME).

TABLE 16

WORLD SUPPLY AND DEMAND

(Thousand metric tons)

Year	Mine production	Primary demand1/	Apparent consumption	Stock changes (ILZSG)	Refinery production	Production surplus/deficit
1978	3,395	60%	5,595	-71	5,524	+91
1979	3,472		5,650	+62	5,712	
1980	3,470		5,364	+66	5,430	
1981	3,366		5,337	-7	5,330	
1982	3,448		5,174	+41	5,215	
1983	3,357	57.6%	5,303	-19	5,284	-174
1984	3,269		5,582	-113	5,469	
1985	3,431		5,587	+54	5,641	
1986	3,345		5,603	-52	5,551	
1987	3,425		5,681	+37	5,718	
1988	3,430	55.5%	5,856	-6	5,850	
1989p/	3,368	53.5%	6,062	-75	5,987	+46
1990e/	3,367		5,896	+46	5,942	
Total	44,143	58%	72,690	-37	72,653	2/-37

2.3% per year average growth

e/Estimated. p/Preliminary.
1/Recoverable content (95%) of mine production (lead in concentrate) divided by apparent consumption.
2/Yearend stocks 1977=468; yearend stocks 1990=431 (estimated; producer, consumer, merchant, LME).

TABLE 17

WORLD PRIMARY PRODUCTION CAPACITY, ANNUAL

(Thousand metric tons)

	1989			1990		
	Mine	Smelter	Refinery	Mine	Smelter	Refinery
North America:						
Canada	370	230	230	381	230	230
Mexico	210	300	320	210	300	320
United States	680	r/525	r/605	759	525	605
Other	10	--	--	10	--	--
Total	1,270	r/1,055	r/1,155	1,360	1,055	1,155
South America:						
Peru	210	115	110	212	115	110
Other	85	140	140	88	140	140
Total	295	255	250	300	255	250
Europe:						
Belgium	--	90	125	--	90	125
Bulgariae/	100	130	120	100	130	120
France	2	190	150	1	190	150
Germany, Federal Republic of	7	190	250	7	210	270
Italy	18	115	100	18	130	100
Poland	50	90	90	50	90	90
Spain	92	85	85	72	85	85
U.S.S.R.e/	550	635	675	550	635	675
United Kingdom	--	50	160	--	50	160
Yugoslavia	116	155	155	112	130	155
Other	220	150	110	202	130	90
Total	1,155	1,880	2,020	1,112	1,870	2,020
Africa:						
Morocco	74	65	65	74	65	65
Namibia	40	75	75	40	75	75
South Africa, Republic of	102	--	--	102	--	--
Other	24	30	15	24	30	15
Total	240	170	155	240	170	155
Asia:						
Chinae/	350	r/250	r/250	370	250	250
Japan	30	270	285	28	275	290
North Koreae/	85	90	70	85	90	70
Other	100	95	150	100	80	135
Total	565	r/705	r/755	583	695	745
Oceania: Australia	575	445	235	590	445	235
World total	4,100	r/4,510	r/4,570	4,185	4,490	4,560

e/Estimated. r/Revised.

Sources: International Lead Zinc Study Group, U.S. Bureau of Mines estimates, and other published sources.

Table 18.--Lead: World mine production of lead in concentrates, by country1/
(Thousand metric tons)

Country2/	1986	1987	1988	1989p/	1990e/
Algeriae/	3.6	3.6	r/3.5	r/3.2	3.2
Argentina	26.9	26.1	28.5	26.7	27.0
Australia	447.7	489.1	465.5	495.0	3/563.0
Austria	4.7	5.2	2.3	1.6	1.5
Bolivia	3.1	9.0	12.5	15.7	18.6
Brazil	13.6	11.6	14.3	16.1	16.0
Bulgariae/	r/65.0	r/60.0	r/60.0	3/57.0	55.0
Burma	r/6.6	r/4.6	6.0	5.2	4.4
Canada	349.3	413.7	368.4	275.0	3/236.2
Chile	1.5	.8	1.4	1.2	3/1.1
China	227.0	r/267.0	312.0	341.0	3/315.0
Colombia	.2	.2	(4/)	.4	.3
Congo (Brazzaville)	e/1.4	e/1.4	1.8	1.0	1.0
Czechoslovakia	2.9	2.8	e/2.8	2.7	2.6
Ecuadore/	.2	.2	.2	.2	.2
Finland	2.0	e/2.9	1.9	2.6	2.5
France	2.5	2.2	2.0	1.1	1.2
Federal Republic of Germany:					
Western states	16.7	18.8	14.3	r/ e/7.3	7.0
Greece	20.9	20.6	23.1	22.7	22.5
Greenland	16.2	20.5	23.1	24.1	18.0
Honduras	12.6	5.0	16.9	e/10.0	10.0
India	37.6	36.7	30.5	26.5	28.0
Iran	22.0	20.0	17.0	10.5	12.0
Ireland	36.4	33.8	32.5	e/32.1	35.3
Italy	11.1	12.0	16.5	17.0	15.0
Japan	40.3	27.9	22.9	18.6	3/18.7
Kenyae/ 5/	.6	.5	.6	.6	.6
Korea, Northe/	110.0	110.0	110.0	r/120.0	120.0
Korea, Republic of	11.9	14.0	14.5	16.5	15.5
Mexico	182.7	177.2	171.3	163.0	3/179.9
Morocco	76.2	75.7	72.2	67.3	67.0
Namibia	37.5	33.0	37.2	23.7	23.0
Nigeria	e/.1	.1	e/.1	(6/)	--
Norway	3.4	3.1	2.8	3.2	3.0
Peru	194.4	204.0	149.0	192.2	3/189.0
Polande/	r/31.2	r/37.5	r/40.6	r/42.0	33.0
Romaniae/	34.3	36.3	30.2	3/37.7	35.0
South Africa, Republic of	97.8	93.6	90.2	78.2	3/69.4
Spain	79.6	r/83.3	74.7	62.6	60.3
Sweden	88.9	90.4	91.6	89.0	90.0
Thailand	26.3	23.5	29.5	25.1	3/22.2
Tunisia	1.9	3.5	3.7	2.7	2.7
Turkey	r/7.5	r/7.3	9.4	r/ e/10.5	10.5
U.S.S.R.e/ 7/	r/520.0	r/510.0	r/520.0	r/500.0	450.0
United Kingdom	.6	.7	1.2	e/.8	.6
United States	353.1	318.7	394.0	420.2	3/495.2
Yugoslavia	r/103.0	r/94.0	95.0	86.0	3/73.0
Zambia8/	r/12.2	r/12.5	12.1	r/ e/12.0	12.0
Total	r/3,345.2	r/3,424.6	3,429.8	3,367.8	3,367.2

e/Estimated. p/Preliminary. r/Revised.

1/Table includes data available through June 14, 1991.

2/In addition to the countries listed, Uganda may produce lead, but available information is inadequate to make reliable estimates of output levels.

3/Reported figure.

4/Less than 1/2 unit.

5/Reported for 1987 and 1988 as galena (not further specified), assumed 78% Pb.

6/Revised to zero.

7/Estimated by International Lead Zinc Study Group Secretariat.

8/Pb content of ore.

Table 19.-Lead: World refinery production, by country1/
(Thousand metric tons)

Country	1986	1987	1988	1989p/	1990e/
Argentina:					
Primary	15.7	16.2	14.0	13.0	14.0
Secondary	15.0	16.0	15.0	13.0	13.0
Total	30.7	32.2	29.0	26.0	27.0
Australia:					
Primary	156.2	201.7	168.0	193.0	2/212.0
Secondarye/	14.8	15.0	15.0	15.0	15.0
Totale/	171.0	216.7	183.0	r/208.0	227.0
Austria:					
Primary	6.0	6.8	9.0	8.8	8.8
Secondary	19.0	16.0	16.0	15.2	15.2
Total	25.0	22.8	25.0	24.0	24.0
Belgium:					
Primary	64.5	71.1	83.2	72.7	75.0
Secondary	33.8	36.9	43.4	36.8	45.0
Total3/	98.3	108.0	126.6	109.4	120.0
Bolivia: Primary	.2	.2	(4/)	(4/)	(4/)
Brazil:					
Primary	32.7	29.8	29.5	33.5	33.0
Secondary	52.0	58.4	68.7	53.3	55.0
Total	84.7	88.2	98.2	86.8	88.0
Bulgaria:e/					
Primary	r/95.0	r/88.0	r/88.0	r/89.0	89.0
Secondary	17.0	17.0	17.0	10.0	10.0
Total	r/112.0	r/105.0	r/105.0	r/99.0	99.0
Burma: Primary	5.4	4.0	4.4	3.4	2.8
Canada:					
Primary	169.9	139.5	178.6	157.3	125.8
Secondary	87.7	91.2	89.4	87.2	98.3
Total3/	r/257.7	230.7	268.1	244.5	224.0
China:e/					
Primary	200.0	200.0	200.0	r/245.0	235.0
Secondary	40.0	r/45.0	45.0	r/55.0	55.0
Total	240.0	r/245.0	245.0	r/300.0	290.0

Table 19.-Lead: World refinery production, by country1/-Continued
(Thousand metric tons)

Country	1986	1987	1988	1989p/	1990e/
Colombia: Secondarye/	4.0	4.0	4.0	3.5	3.5
Czechoslovakia: Secondary	23.6	26.0	26.0	26.0	25.5
Denmark: Secondary	.6	--	--	--	--
Finland: Secondarye/	2/1.2	1.2	2.0	2.0	2.0
France:					
Primary	132.0	138.8	146.5	149.3	150.0
Secondary	98.4	107.1	109.2	118.1	110.0
Total	230.4	245.9	255.7	267.4	260.0
Germany, Federal Republic of:					
Eastern states:e/					
Primary	15.5	17.1	19.2	18.2	18.0
Secondary	29.0	32.0	35.8	33.8	30.0
Total	44.5	49.1	55.0	52.0	48.0
Western states:					
Primary	182.1	167.6	176.6	181.8	180.5
Secondary	184.5	172.8	168.5	168.0	168.0
Total	366.6	340.4	345.1	349.8	348.5
Greece: Primary	19.3	2.7	15.1	7.0	7.2
Guatemala: Secondary	.1	.1	.1	.2	.2
Hungary: Secondarye/	.1	.1	.1	.1	.1
India:					
Primary	19.9	20.7	18.8	21.3	22.0
Secondary	11.3	12.1	9.9	13.5	13.5
Total3/	31.2	32.8	28.7	34.7	35.5
Iran: Secondarye/	8.0	10.0	10.0	10.0	10.0
Ireland: Secondary	10.2	9.6	11.7	r/ e/12.0	12.0
Italy:					
Primary	29.3	62.3	72.2	74.2	72.0
Secondary	101.7	111.4	111.6	112.0	100.0
Total	131.0	173.7	183.8	186.2	172.0
Jamaica: Secondarye/	1.0	1.0	1.0	1.0	1.0
Japan:					
Primary	232.7	218.8	217.7	207.7	2/204.9
Secondary	128.7	119.5	122.2	125.6	2/124.1
Total3/	r/361.5	338.3	340.0	333.4	2/329.0
Kenya: Secondarye/	2.0	2.0	2.0	1.0	1.0
Korea, North: Primarye/	95.0	95.0	95.0	95.0	95.0

Table 19.-Lead: World refinery production, by country1/-Continued
(Thousand metric tons)

Country	1986	1987	1988	1989p/	1990e/
Korea, Republic of:e/					
Primary	32.1	52.5	46.0	36.8	38.0
Secondary	27.5	30.0	44.0	44.1	45.0
Total	59.6	82.5	90.0	80.9	83.0
Malaysia: Secondary	r/12.0	r/9.0	15.0	16.0	15.2
Mexico:					
Primary	182.0	177.0	171.1	162.5	179.0
Secondarye/	33.0	2/35.0	35.0	35.0	35.0
Total	215.0	212.0	206.1	197.5	214.0
Morocco:					
Primary	60.0	62.5	68.4	63.7	64.0
Secondarye/	2.0	2.0	2.0	2.0	2.0
Totale/	62.0	64.5	r/70.4	r/65.7	66.0
Namibia: Primary	40.0	40.6	44.4	44.2	44.0
Netherlands : Secondarye/	r/36.0	r/40.0	r/39.0	r/43.0	35.0
New Zealand: Secondarye/	4.0	2/3.6	3.0	5.0	5.0
Nigeria: Secondary	1.0	.3	e/.5	e/.5	.3
Pakistan: Secondarye/	1.0	2.0	2.0	2.0	2.5
Peru:					
Primary	66.4	71.3	56.5	73.4	69.3
Secondarye/	5.0	5.0	5.0	5.0	5.0
Totale/	71.4	76.3	r/61.5	r/78.4	74.3
Philippines: Secondarye/	7.0	7.0	7.0	7.0	7.0
Poland:					
Primarye/	63.3	64.5	61.0	61.0	57.0
Secondarye/	25.0	25.0	r/30.0	20.0	22.0
Total	88.3	89.5	91.0	81.0	79.0
Portugal: Secondarye/	6.0	6.5	6.5	6.5	7.0

Table 19.-Lead: World refinery production, by country1/-Continued
(Thousand metric tons)

Country	1986	1987	1988	1989p/	1990e/
Romania:e/					
Primary	36.0	2/33.2	38.0	45.0	40.0
Secondary	15.5	10.0	10.0	15.0	10.0
Total	51.5	43.2	48.0	60.0	50.0
South Africa, Republic of: Secondary	40.5	38.3	37.4	36.9	34.6
Spain:					
Primary	88.0	71.4	e/68.8	68.3	70.0
Secondary	42.0	51.3	e/52.0	45.0	50.0
Total	130.0	122.7	e/120.8	113.3	120.0
Sweden:					
Primary	49.2	61.2	57.8	48.7	47.5
Secondary	27.8	30.2	26.9	22.7	22.1
Total3/	r/76.9	91.4	84.7	71.4	69.6
Switzerland: Secondary	2.5	2.5	1.5	e/1.4	1.4
Taiwan: Secondarye/	53.5	66.4	67.3	r/58.2	57.6
Thailand: Secondary	9.1	11.4	15.6	18.7	2/15.9
Trinidad and Tobago: Secondarye/	2.0	1.8	1.8	1.8	1.8
Tunisia:e/					
Primary	2/2.2	2.2	2.2	2.2	2.2
Secondary	.5	.5	.5	.5	.5
Total	2.7	2.7	2.7	2.7	2.7
Turkey:e/					
Primary	7.0	7.0	7.3	r/6.3	8.4
Secondary	2.6	3.0	3.7	r/2.7	3.6
Total	9.6	10.0	11.0	r/9.0	12.0
U.S.S.R.:e/					
Primary	485.0	475.0	447.0	r/465.0	420.0
Secondary	270.0	275.0	280.0	280.0	280.0
Total	755.0	750.0	727.0	r/745.0	700.0

Table 19.-Lead: World refinery production, by country1/-Continued
(Thousand metric tons)

Country	1986	1987	1988	1989p/	1990e/
United Kingdom:					
Primary	156.1	137.5	172.2	156.5	160.0
Secondary	172.5	200.7	201.6	193.5	200.0
Total	328.6	338.2	373.8	350.0	360.0
United States:					
Primary	370.3	373.6	392.1	396.5	2/403.7
Secondary	624.8	710.2	736.4	891.3	2/922.9
Total	995.1	1,083.8	1,128.5	1,287.8	2/1,326.6
Venezuela: Secondarye/	16.0	17.0	r/18.0	17.0	17.0
Yugoslavia:					
Primary	75.0	76.4	70.9	r/ e/78.2	60.0
Secondary	38.0	36.0	e/39.0	r/ e/19.0	22.0
Total	113.0	112.4	109.9	r/ e/97.2	2/82.0
Zambia: Primary5/	r/6.8	r/7.6	6.3	r/ e/6.0	6.0
Grand total3/	r/5,551.4	r/5,717.7	5,850.4	5,986.6	5,941.7
of which:					
Primary	r/3,190.9	r/3,193.7	3,246.0	3,284.5	3,214.0
Secondary	r/2,360.5	r/2,524.1	2,604.4	2,702.1	2,727.7

e/Estimated. p/Preliminary. r/Revised.
1/Table includes data available through June 14, 1991. Data included represent the total output of refined l by each country, whether derived from ores and concentrates (primary) or scrap (secondary), and include the l content of antimonial lead, but exclude, to the extent possible, simple remelting of scrap. .
2/Reported figure.
3/Data may not add to totals shown because of independent rounding.
4/Less than 50 tons.
5/Data are for fiscal year beginning Apr. l of that stated.

TABLE 20

PRODUCTION AND SHIPMENTS OF LEAD PIGMENTS1/ AND OXIDES IN THE UNITED STATES

(Metric tons unless otherwise specified)

Product	1989				1990			
	Production		Shipments		Production		Shipments	
	Gross weight	Lead content	Quantity	Value2/	Gross weight	Lead content	Quantity	Value2/
White lead, dry	W	W	W	W	W	W	W	W
Litharge and red lead	78,733	73,000	81,684	$82,655,677	85,855	79,717	78,958	$65,010,852
Leady oxide	472,112	448,507	NA	NA	453,076	430,422	NA	NA
Total3/	550,845	521,507	NA	NA	538,933	510,140	NA	NA

NA Not available. W Withheld to avoid disclosing company proprietary data.
1/Excludes basic lead sulfate; withheld to avoid disclosing company proprietary data.
2/At plant, exclusive of container.
3/Data may not add to totals shown because of independent rounding.

TABLE 21

U.S. IMPORTS FOR CONSUMPTION OF LEAD PIGMENTS AND COMPOUNDS, BY KIND

Kind	Quantity (metric tons)	Value (thousands)
1989		
White lead carbonate	191	$240
Red and orange lead	533	480
Chrome yellow and molybdenum orange pigments and lead-zinc chromates	4,295	8,578
Litharge	9,531	7,744
Leady litharge	1	1
Glass frits (undifferentiated)	6,219	9,987
Total	20,770	27,030
1990		
White lead carbonate	72	120
Red and orange lead	212	298
Chrome yellow and molybdenum orange pigments and lead-zinc chromates	15,146	18,573
Litharge	--	--
Leady litharge	183	182
Glass frits (undifferentiated)	6,552	11,358
Total	22,165	1/30,530

1/Data do not add to total shown because of independent rounding.

Source: Bureau of the Census.

TABLE 22

U.S. EXPORTS OF LEAD, BY COUNTRY

Country	1989		1990	
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
Ore and concentrates (lead content):				
Belgium	1,114	$345	17,346	$9,492
Brazil	--	--	4,718	3,061
Canada	38,706	12,773	19,484	12,421
India	3,959	1,764	9,511	4,931
Italy	--	--	1,867	1,685
Japan	1,646	759	2,898	1,015
Korea, Republic of	733	308	--	--
Mexico	944	303	101	31
Netherlands	109	58	--	--
Spain	7,788	6,383	--	--
Taiwan	748	243	--	--
U.S.S.R.	485	303	--	--
United Kingdom	441	125	632	713
Other	365	152	43	20
Total	57,038	23,516	56,600	33,369
Ash and residues (lead content):				
Belgium	9,560	5,221	11,656	6,895
Brazil	--	--	889	241
Canada	18	19	2	4
France	--	--	69	188
Germany, Federal Republic of	179	200	37	617
India	68	18	86	81
United Kingdom	125	140	14	57
Other	10	14	11	14
Total1/	9,960	5,612	12,765	8,096
Unwrought lead and lead alloys (lead content):				
Australia	87	133	--	--
Belgium	25	61	28	69
Brazil	--	--	96	206
Canada	4,017	3,500	7,286	6,647
Chile	250	280	283	258
China	978	776	19	32
Dominican Republic	7	6	19	18
Germany, Federal Republic of	19	30	39	52
Haiti	65	233	69	109
Hong Kong	108	100	320	374
Indonesia	18	18	17	21
Israel	3,377	2,579	1,934	1,820
Italy	29	49	3,004	3,354
Japan	1,619	1,873	4,049	5,648
Korea, Republic of	4,384	4,777	14,488	15,321
Malaysia	3,005	2,114	3,720	4,801
Malta	3	13	28	38
Mexico	689	660	145	191
Netherlands	1,597	1,774	2,826	2,366
Peru	80	149	23	47
Philippines	60	79	21	19
Singapore	4,010	3,409	5,623	5,021
South Africa, Republic of	9	54	--	--
Sudan	170	169	313	263
Taiwan	3,518	6,312	11,553	11,229
Trinidad and Tobago2/	159	100	17	18
United Kingdom	127	575	1,133	910
Other	102	268	172	250
Total1/	28,512	30,091	57,226	59,080

See footnotes at end of table.

TABLE 22-Continued

U.S. EXPORTS OF LEAD, BY COUNTRY

Country	1989		1990	
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
Wrought lead and lead alloys (lead content):				
Antigua	18	$25	--	--
Argentina	6	24	15	$20
Australia	7	73	14	107
Bahamas	--	--	50	79
Barbados	10	51	1	9
Belgium	11	33	108	287
Bermuda	5	7	--	--
Brazil	--	--	57	148
British Virgin Islands	10	8	4	3
Canada	1,994	2,748	1,362	3,136
Chile	2	18	8	37
Colombia	29	111	30	75
Dominican Republic	4	25	24	45
Ecuador	27	63	4	8
Egypt	5	2	51	222
Finland	18	100	1	7
France	62	430	31	138
Germany, Federal Republic of	516	808	214	586
Guatemala	10	35	5	15
Haiti	21	72	24	89
Hong Kong	115	410	162	407
India	121	231	255	181
Israel	37	164	67	177
Italy	19	119	1,126	2,088
Jamaica	10	24	--	--
Japan	312	1,255	336	2,821
Korea, Republic of	61	329	319	781
Malta	12	83	(3/)	21
Mexico	1,110	2,999	1,527	5,301
Netherlands	193	428	112	352
Philippines	34	223	30	142
Saudia Arabia	49	145	48	216
Singapore	59	829	38	268
Spain	167	747	128	219
Sweden	14	94	--	--
Taiwan	58	240	214	679
Thailand	21	267	38	306
United Arab Emirates	5	7	--	--
United Kingdom	148	402	134	333
Venezuela	23	102	88	57
Other	42	382	131	563
Total1/	5,365	14,113	6,759	19,923
Grand total1/	100,875	73,332	133,349	120,468
Scrap (gross weight):				
Bahamas	380	45	127	129
Belgium	1,173	291	87	34
Brazil	4,559	1,550	2,512	1,111
Canada	10,646	4,658	34,497	11,190
Chile	105	10	--	--
China	3,054	703	3,507	1,472
France	549	146	640	221
Germany, Federal Republic of	1,618	363	4,551	1,629
Honduras	50	5	--	--
Hong Kong	--	--	492	440
India	5,768	2,623	1,989	702
Indonesia	--	--	1,394	678
Ireland	--	--	198	131
Italy	--	--	511	61
Japan	1,296	4,060	1,135	1,347
Korea, Republic of	3,655	4,601	2,301	2,324
Mexico	10,755	2,854	9,391	4,427
Netherlands	3,010	728	94	47
Netherlands Antilles	89	46	6	27
Panama	96	26	86	23
Philippines	26	5	44	190
Saudi Arabia	1,573	288	(3/)	3
Singapore	272	159	644	541
South Africa, Republic of	877	377	1,536	1,235
Spain	6,155	690	858	1,962
Taiwan	997	654	3,369	1,808
Thailand	--	--	220	119
Trinidad and Tobago2/	--	--	291	59
United Arab Emirates	91	21	--	--
United Kingdom	2,232	886	4,804	1,717
Venezuela	739	174	81	45
Other	144	202	139	264
Total1/	59,909	26,165	75,507	33,934

1/Data may not add to totals shown because of independent rounding.
2/Data for 1989 was listed for "Trinidad" only; correct country title is as listed.
3/Less than 1/2 unit.

Source: Bureau of the Census.

TABLE 23

U.S. EXPORTS OF LEAD1/

Year	Blocks, pigs, anodes, etc.				Wrought lead and lead alloys				Scrap (gross weight)		Ash and residues5/	
	Unwrought2/		Unwrought alloys		All forms, including foil and wire3/		Powder and flakes4/					
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
1988 -----	6,413	$6,196	1,133	$1,893	5,848	$7,582	200	$248	81,910	$23,212	15,483	$8,808
19896/ ---	23,787	25,909	4,725	4,182	5,053	12,874	312	1,239	59,909	26,165	9,960	5,612
1990 -----	50,194	50,554	7,031	8,526	6,030	18,987	729	936	75,507	33,934	12,765	8,096

1/Lead content, unless otherwise specified.
2/Includes bullion.
3/Before 1989, title was "Sheets, plates, rods, other forms."
4/Before 1989, title was "Foil, powder, flakes."
5/Before 1989, title was "Drosses, etc."
6/Because of the implementation of the Harmonized Tariff System in Jan. 1989, export categories for 1989 and 1990 are not necessarily comparable with those in 1988.

Source: Bureau of the Census.

TABLE 24

U.S. IMPORTS1/ OF LEAD, BY COUNTRY

Country	1988		19892/		1990	
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
Ore and concentrates:3/						
Australia	1,431	$631	r/1,127	r/$770	1,285	$887
Bolivia	377	191	r/21	r/7	19	11
Canada	221,785	72,976	r/110,938	r/36,540	124,353	43,062
Chile	3	1	--	--	--	--
Honduras	--	--	21	11	--	--
Italy	--	--	--	--	138	175
Mexico	--	--	r/15	r/17	1,154	834
Peru	11,436	6,077	r/7,604	r/3,123	7,132	4,817
Switzerland	--	--	--	--	73	18
Total	235,032	79,876	r/119,726	r/40,468	134,154	49,804
Base bullion:						
Belgium	999	737	--	--	--	--
Canada	50	33	37	31	38	30
China	34	15	345	173	91	43
France	249	170	--	--	--	--
Korea, Republic of	76	49	--	--	--	--
Mexico	1,213	779	5,400	4,334	2,584	1,563
Morocco	376	267	--	--	--	--
Peru	501	354	--	--	--	--
Sweden	2,002	1,498	--	--	--	--
United Kingdom	999	660	--	--	--	--
Other	50	33	--	--	--	--
Total	6,549	4,595	5,782	4,538	2,713	1,636
Pigs and bars:						
Australia	6,719	3,981	--	--	6,992	5,751
Belgium	499	310	41	25	--	--
Bolivia	36	22	52	48	--	--
Brazil	(4/)	2	1,510	974	--	--
Canada	104,815	77,207	90,479	61,951	70,662	58,099
China	653	403	6	5	--	--
France	299	94	--	--	--	--
Germany, Federal Republic of	1,212	1,446	144	269	66	253
India	--	--	--	--	330	223
Italy	1,800	1,139	1,731	1,238	--	--
Mexico	30,937	21,580	19,178	13,232	24,666	19,988
Netherlands	--	--	--	--	5	5
Peru	--	--	4,316	2,913	1,000	822
Switzerland	58	40	--	--	--	--
United Arab Emirates	8	44	296	510	239	646
United Kingdom	88	161	--	--	269	332
Venezuela	--	--	126	81	13	11
Yugoslavia	--	--	277	319	--	--
Total	147,124	106,429	118,156	81,565	5/104,241	5/86,129
Reclaimed scrap, including ash and residues:6/ 7/						
Canada	2,854	1,230	487	182	233	119
Costa Rica	52	28	--	--	--	--
Japan	16	90	(4/)	4	--	--
Mexico	4,202	1,845	--	--	116	30
Netherlands Antilles	22	3	332	169	--	--
Panama	92	53	--	--	--	--
United Arab Emirates	25	78	--	--	--	--
Other	26	12	--	--	--	--
Total	7,289	3,339	819	355	349	149
Grand total	395,994	194,239	r/244,483	r/126,926	241,457	137,718

r/Revised.

1/Data are "general imports;" that is, they include lead imported for immediate consumption plus material entering the country under bond.

2/Because of the implementation of the Harmonized Tariff System in Jan. 1989, import categories for 1989 and 1990 are not necessarily comparable with those in 1988.

3/Also includes other lead-bearing materials containing greater than 5 troy ounces of gold per short ton, or greater than 100 troy ounces of total precious metals per short ton.

4/Less than 1/2 unit.

5/Data do not add to total shown because of independent rounding.

6/Also includes other lead-bearing materials containing greater than 10% by weight of copper, lead, or zinc (any one).

7/Before 1989, title was "Reclaimed scrap, including drosses."

Source: Bureau of the Census.

TABLE 25

U.S. IMPORTS FOR CONSUMPTION OF LEAD, BY COUNTRY

Country	1988		19891/		1990	
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
Ore and concentrates (lead content):2/						
Australia	6,656	$3,508	--	--	1,033	$378
Canada	8,171	3,995	r/1,170	r/$442	1,494	321
Honduras	1,396	1,016	21	11	--	--
Italy	--	--	--	--	138	175
Mexico	--	--	r/15	r/17	1,177	839
Peru	4,383	2,705	r/1,733	r/653	3,875	1,725
Switzerland	--	--	--	--	73	18
Total	20,606	11,224	r/2,939	r/1,123	7,790	3,456
Base bullion (lead content):						
Belgium	999	737	--	--	--	--
Canada	50	33	37	31	38	30
China	34	15	345	173	91	43
France	249	170	--	--	--	--
Korea, Republic of	76	49	--	--	--	--
Mexico	1,213	779	5,400	4,334	2,584	1,563
Morocco	376	267	--	--	--	--
United Kingdom	999	660	--	--	--	--
Other	50	33	--	--	--	--
Total	4,046	2,743	5,782	4,538	2,713	1,636
Pigs and bars (lead content):						
Australia	6,719	3,981	--	--	--	--
Belgium	499	310	41	25	--	--
Bolivia	36	22	52	48	--	--
Brazil	(3/)	2	1,510	974	--	--
Canada	104,815	77,207	90,479	61,951	70,662	58,099
China	653	403	6	5	--	--
France	299	94	--	--	--	--
Germany, Federal Republic of	2,713	2,519	144	269	66	253
India	--	--	--	--	330	223
Italy	1,800	1,139	1,731	1,238	--	--
Mexico	30,916	21,562	18,703	12,900	18,055	14,005
Peru	--	--	2,316	1,543	1,000	822
Switzerland	58	40	--	--	--	--
United Arab Emirates	8	44	296	510	239	646
United Kingdom	88	161	277	319	269	332
Venezuela	--	--	126	81	13	11
Total4/	148,604	107,484	115,681	79,863	90,638	74,395
Reclaimed scrap, including ash and residues (lead content):5/ 6/						
Canada	2,854	1,230	345	113	165	72
Costa Rica	52	28	--	--	--	--
Japan	16	90	(3/)	4	--	--
Mexico	4,202	1,845	--	--	116	30
Netherlands Antilles	22	3	332	169	--	--
Panama	92	53	--	--	--	--
United Arab Emirates	25	78	--	--	--	--
Other	26	12	--	--	--	--
Total	7,289	3,339	677	286	281	102
Grand total4/	180,545	124,790	r/125,079	r/85,810	101,421	79,589
Wrought lead, all forms, including wire and powders (gross weight):7/						
Belgium	32	65	68	181	1	86
Canada	283	472	770	1,257	1,152	2,068
China	--	--	279	719	278	771
France	--	--	--	--	21	140
Germany, Federal Republic of	199	494	244	837	258	1,167
Italy	39	87	50	160	330	448
Japan	3	76	37	393	37	399
Mexico	2,285	1,280	2,539	1,797	2,769	2,061
Netherlands	--	--	--	--	55	241
Peru	40	28	1,284	927	735	628
Spain	45	101	7	117	4	96
Taiwan	7	18	248	658	178	495
Thailand	--	--	--	--	30	120
United Arab Emirates	--	--	--	--	40	101
United Kingdom	478	586	406	989	88	513
Venezuela	--	--	--	--	709	366
Other	34	73	136	1,041	40	245
Total	3,445	3,280	6,068	9,076	6,723	9,944

r/Revised.
1/Because of the implementation of the Harmonized Tariff System in Jan. 1989, import categories for 1989 and 1990 are not necessarily comparable with those in 1988.
2/Also includes other lead-bearing materials containing greater than 5 troy ounces of gold per short ton, or greater than 100 troy ounces of total precious metals per short ton.
3/Less than 1/2 unit.
4/Data may not add to totals shown because of independent rounding.
5/Also includes other lead-bearing materials containing greater than 10% by weight of copper, lead, or zinc (any one).
6/Before 1989, title was "Reclaimed scrap, etc."
7/Before 1989, title was "Sheets, pipe, shot, other forms."

Source: Bureau of the Census.

TABLE 26

U.S. IMPORTS FOR CONSUMPTION OF LEAD1/

Year	Blocks, pigs, anodes, etc.		Wrought lead and lead alloys (gross weight)						Scrap		Drosses, etc.	
	Unwrought2/		Unwrought alloys		Sheets, plates, rods, other forms		Foil, powder, flakes					
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
1988 ---	137,598	$97,565	15,052	$12,662	3,331	$3,101	114	$179	6,938	$3,094	351	$245

Year	Blocks, pigs, anodes, etc.		Wrought lead and lead alloys (gross weight)								Scrap		Ash and residues	
	Unwrought2/		Unwrought alloys		Strip, sheets, plates, and foil		Bars, rods, tubes, pipe, wire, fittings		Powders and flakes					
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
19893/ ---	102,319	$71,823	19,144	$12,578	718	$1,356	5,337	$7,670	13	$50	--	--	677	$286
1990 -----	81,490	65,059	11,861	10,972	427	1,126	6,197	8,634	98	185	--	--	281	102

1/Lead content, unless otherwise specified.
2/Includes bullion.
3/Because of the implementation of the Harmonized Tariff System in Jan. 1989, import categories for 1989 and 1990 are not necessarily comparable with those in 1988.

Source: Bureau of the Census.

TABLE 27

U.S. IMPORTS FOR CONSUMPTION OF MISCELLANEOUS PRODUCTS CONTAINING LEAD1/

Year	Gross weight (metric tons)	Lead content (metric tons)	Value (thousands)
1987 ----------	970	515	$4,185
1988 ----------	1,623	992	8,838
19892/ ----------	1,789	852	11,908
1990 ----------	1,238	515	6,782

1/Babbitt metal, solder, white metal, and other lead-containing combinations.
2/Because of the implementation of the Harmonized Tariff System in Jan. 1989, import categories for 1989 and 1990 are not necessarily comparable with those in previous years.

Source: Bureau of the Census.

United States
Environmental Protection
Agency

Office of Air Quality
Planning and Standards
Research Triangle Park NC 27711

EPA-450/3-79-028a
November 1979

Ref (5)

Air

EPA

Lead-Acid Battery Manufacture - Background Information for Proposed Standards

Draft EIS

EPA-450/3-79-028a

Lead-Acid Battery Manufacture - Background Information for Proposed Standards

Emission Standards and Engineering Division

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air, Noise, and Radiation
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

November 1979

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Publication No. EPA-450/3-79-028a

Background Information
and Draft
Environmental Impact Statement
for Lead-Acid Battery Manufacture

Type of Action: Administrative

Prepared by:

Don R. Goodwin, Director
Emission Standards and Engineering Division
U. S. Environmental Protection Agency
Research Triangle Park, North Carolina 27711

(Date)

Approved by:

SEP 17 1979

(Date)

for David G. Hawkins
Assistant Administrator for Air,
Noise and Radiation
U. S. Environmental Protection Agency
Washington, D. C. 20460

Draft Statement Submitted to EPA's
Office of Federal Activities Review on

(Date)

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